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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/255,856	02/23/1999	TOMIO IWASAKI	501.39631X00	9089

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EXAMINER

SMOOT, STEPHEN W

ART UNIT	PAPER NUMBER
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2813

23

DATE MAILED: 03/18/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Applicati n No.

09/255,856

Applicant(s)

IWASAKI ET AL.

Examiner

Stephen W. Smoot

Art Unit

2813

-- The MAILING DATE of this communication appears in the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 04 March 2002.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-6, 9-20, 22-25 and 27-37 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 1, 2, 4-6, 9-20, 22-25, 27-29, 31-35 and 37 is/are allowed.
- 6) ☒ Claim(s) 3, 30 and 36 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 23 February 1999 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

Response to Amendment

1. Applicant's request for reconsideration of the finality of the rejection of the last Office action is persuasive and, therefore, the finality of that action is withdrawn.

Claim Objections

2. Claim 30 (Amended) is objected to because of the following informality:

In claim 30 (Amended), line 10, change "cupper" to --copper--.

Appropriate correction is required.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 3, 30, 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hussein et al. in view of the IBM Technical Disclosure Bulletin.

Referring to Fig. 3 and column 3, lines 1-13, Hussein et al. disclose the following limitations set forth in claims 3, 30, 36: a semiconductor substrate (1), a dielectric layer (3) with vias (4), a diffusion barrier (5) formed over the dielectric layer (3) also lines the via walls (20) and the via bottom surface (22), and interconnect layers (7, 30) that can be copper (see column 3, lines 50-53). Layer 7 is a liner layer that is applied to the barrier layer 5 (see column 3, lines 55-57) and therefore layers 5 and 7 "neighbor " each other. Also, the barrier layer (5) is between the dielectric layer (3) and the interconnect layers (7, 30). However, Hussein et al. do not disclose ruthenium (nor, alternatively, rhodium, iridium, osmium, or platinum) as a diffusion barrier material. The IBM Technical Disclosure Bulletin does teach that ruthenium (as well as rhenium, osmium, and iridium) is an exceptional barrier against the diffusion of copper (see first sentence of final paragraph).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the teachings of the IBM Technical Disclosure Bulletin with those of Hussein et al. and use ruthenium as a diffusion barrier material. Hussein et al. recognize that copper diffusion into silicon and, also into any surrounding dielectric material, can result in defective circuitry (see column 1, lines 55-57).

Response to Arguments

5. Applicant's arguments filed 04 March 2002 (Paper No. 22, pages 7-15) have been fully considered but they are not persuasive.

Regarding the formation of copper layers by sputtering, plating, PVD, and/or CVD (see Paper No. 22, paragraph bridging pages 8 and 9), these are process limitations and the patentability of a product does not depend on its method of production (see MPEP section 2113). Also, applicant's previous argument (see Paper no. 20, page 17, last paragraph) is not persuasive because *In re Luck* specifies that the process limitations must distinguish the product over the prior art.

Regarding the avoidance of copper electromigration (see paragraph bridging pages 11 and 12), claims 3, 30, 36 are silent with respect to electromigration.

Regarding applicant's argument concerning the diffusion of copper into silicon versus the diffusion of copper into silicon oxide (see Paper No. 22, pages 12-15), the underlying layer of Hussein et al. is the semiconductor substrate (1), typically silicon (see column 1, lines 12-21), and the vias (4) are formed for subsequently making electrical contact to the underlying substrate (see column 1, lines 15-21 and column 3, lines 1-5). So, the barrier layer (5) of Hussein et al. does prevent diffusion of copper from the interconnects (7, 30) through the bottom (22) of the via (4) into the underlying typically silicon semiconductor substrate (1).

Regarding applicant's argument that there is no motivation to combine Hussein et al. and the IBM Technical Disclosure Bulletin (see Paper No. 22, paragraph bridging pages 13 and 14), the motivation as set forth in the IBM Technical Disclosure Bulletin is their discovery that one metal selected from the group consisting of rhenium, ruthenium, osmium, and iridium is an excellent barrier against the diffusion of copper (see first sentence of final paragraph).

Allowable Subject Matter

6. Claims 1-2, 4-6, 9-20, 22-25, 27-29, 31-35, 37 are allowed.
7. The following is a statement of reasons for the indication of allowable subject matter:
 - The prior art of record does not teach or suggest that neighboring layers of rhodium, ruthenium, iridium, osmium, or platinum prevent the formation of voids due to the electromigration of copper.
 - The prior art of record does not teach or suggest an interconnect structure comprising plugs with ruthenium as the primary constituent element.
 - The prior art of record does not teach or suggest the combination of a neighboring film sandwiched between a diffusion barrier layer and a copper (or platinum) film, wherein the neighboring film has rhodium, ruthenium, iridium,

osmium, or platinum (or, in the case of the platinum film, rhodium, ruthenium, iridium, or osmium) as the primary constituent.

Conclusion

8. Applicant's amendment necessitated the new grounds of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen W. Smoot whose telephone number is 703-305-0168. The examiner can normally be reached on M-F (8:00am to 4:30pm).

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 703-306-2794. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

SWS
March 11, 2002

K Christian
Keith Christian
Primary Examiner
Technology Center 2800